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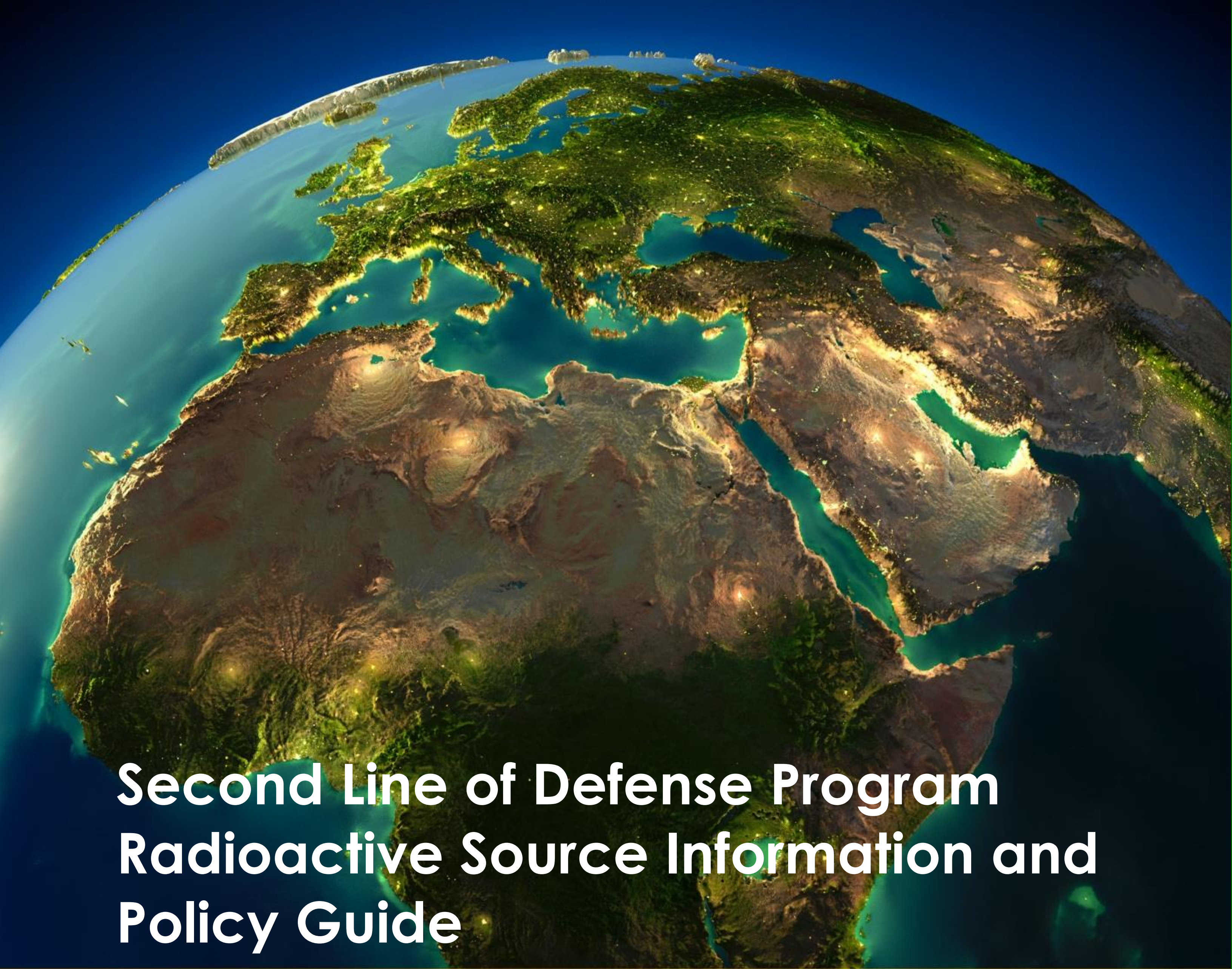

Second Line of Defense Program Radioactive Source Information and Policy Guide

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Revision Table	
Revision 0 (2007-04)	LA-CP-07-0550, Craig Stinson (LANL) - Initial final as a Megaports specific document
Revision 0.1 (2007-05)	LA-CP-07-0550, Craig Stinson (LANL) – Megaports language removed to make generic to SLD Program
Revision 1.0 (2011-05)	Stinson (PNNL), Pappas (DOE-HQ): Revised to expand into two documents: (1) *Radioactive Source Information and Policy Guide* and (2) *SLD Source Management Practitioner Guide*
Revision 1.1 (2014-05)	Removed references to Core and Megaports; minor changes to text and formatting
Revision 1.2 (2014-07)	Per C. Bent: Removed Sustainability Principles figure from Introduction

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Acronym List

AT	acceptance testing
IAEA	International Atomic Energy Agency
LMP	local maintenance provider
MDQ	minimal detectable quantity
RIID	radioactive isotope identification device
RPM	radiation portal monitor
RSS	radioactive sealed sources
SLD	Second Line of Defense

Introduction

The Second Line of Defense (SLD) Program works with partner countries to enhance their capabilities in deterring, detecting, and interdicting the illicit trafficking of nuclear and radiological materials through international borders by providing radiation detection equipment and related training. The program supports sustainability by working with partner countries to establish the functional and operational requirements for people, processes, and equipment that promote proficient performance throughout the lifetime of the radiation detection system.

There are installation, training, operations, and maintenance activities associated with the radiation detection system that require the use of radiation sources of specific isotopes and activities. The storage, handling, transport, and disposal of such radiation sources are subject to national and international regulations. Technical information and program policy associated with these custodial responsibilities are discussed herein. A companion SLD document, *SLD Source Management Practitioner Guide*, addresses the practical aspects of a partner country's custodial responsibilities. Together, these two documents provide the requisite guidance for licensing, procurement, storage, handling, transport, and disposal of the radiation sources necessary to operate and maintain the radiation detection system.

SLD Activities Requiring Radiation Sources

As mentioned above, there are installation, training, operations, and maintenance activities associated with the radiation detection equipment that require use of radioactive sources. The functional utility of the sources for these activities is twofold:

1. Provide specific, certified[1] radiation type, energy and activity levels that are used to both adjust electronic settings to provide a predetermined sensitivity for the detection of radioactive materials of interest and verify acceptable detection performance.
2. Provide gamma and neutron emissions that are used to generate equipment alarms and measured responses for the purposes of maintenance, training, and operational readiness.

The physical characteristics of these specific, certified sources are discussed below.

Installation and Formal Program Acceptance

It is imperative that the certified radiation sources be available for electronic adjustments to the radiation portal monitors (RPMs), technically referred to as alignment, and verification of RPM detection performance (technically referred to as detector efficiency). Proper electronic alignment and detector efficiencies within required specifications provide the technical basis for determining if the RPM meets the program minimal detectable quantity (MDQ) performance requirement. The SLD implementation team will require radiation sources to perform these tasks during RPM installation and as part of formal acceptance testing (AT).

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[1] Radiation source certification relates to commercially procured sources whose isotopic composition and activity has been determined by means traceable to industry standards.

During AT, the same radiation sources are used to systematically generate gamma and neutron alarm signals to test the functionality of the communication system. These functional equipment and system tests serve to verify that integrated operation of the RPM and communication system meets SLD system-level performance requirements.

Maintenance and Repair Activities for RPM and Handheld Equipment

Certified sources are required to perform certain routine maintenance and repair procedures. It is important to note that detector efficiency measurements are not required as a part of routine maintenance and repair activities. Electronic RPM alignment should be completed periodically, typically once a year.

Routine maintenance activities may include replacement of faulty RPM components. When replacing certain components in the course of an equipment repair, such as the SCA-774 board in a Rapiscan/TSA Systems RPM, the local maintenance provider (LMP) will consider performing an electronic alignment. In such instances, the certified sources will be required. Additional repair tasks requiring these sources can be found in the manufacturer's User Manual[2].

As during AT, the same radiation sources are used to systematically generate gamma and neutron alarm signals to test the functionality of the integrated RPM and the communication system. Such functional testing is performed routinely during every site visit by the LMP.

In addition to supporting maintenance of the RPM in either fixed or mobile configuration, the certified gamma radiation sources are used for periodic operational testing of radioactive isotope identification devices (RIIDs). There are no serviceable components for the RIID, either low (sodium-iodide based) or high (high-purity germanium) resolution. Therefore, any faults discovered during the operational testing will require arranging manufacturer repair or replacement (this can be facilitated through the SLD Help Desk in general and specifically, the RIID exchange program[3]).

The full details of maintenance and repair tasks that require the use of the certified sources can be found in the respective LMP contract statement of work[4].

Training Activities for Operators and Maintenance Providers

Training of the LMP on such tasks as RPM alignment will require the use of certified radiation sources. These sources will also be used to train the LMP on routine system functional testing.

The certified sources can also be used by trainers to instruct system operators on the radiation detection equipment and how to recognize and correct simple equipment deficiencies and failures. The use of sources during initial and refresher training is crucial to create the proper training environment. In particular, the detection, search, and isotope identification capabilities of the RPM, survey meter, and RIID are best demonstrated and understood with hands-on training exercises involving realistic scenarios using the certified sources. The specific isotope composition of the certified sources, crucial to their use

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[2] As an example, for the TSA RPM, one should reference *Operations & Service Manual, Vehicle and Pedestrian Monitor, VM-250AGN / PM-700AGN, Doc: # 5000 Rev. A, January 30, 2006,* TSA Systems Ltd.
[3] Typically, the LMP will submit requests for repair support via email to the SLD Help Desk. In some cases, the Help Desk may arrange for the deployed RIID to be exchanged for a new unit from the manufacturer. The SLD Help Desk email address is: sldhelpdesk@pnl.gov.
[4] The SLD Sustainability lead maintains a copy of the statement of work for commercially administered LMPs. Pacific Northwest National Laboratory contract personnel typically manage these contracts.

for RPM electronic alignment and efficiency testing, is of little concern for the training activities. For this reason, alternate sources may be employed for operator training and exercises[5].

Assurance Visits

Assurance visits are part of a performance tracking process intended to identify and correct faulty equipment, inadequate procedures, and training deficiencies. In the context of radiation source requirements, the assurance visit is a blending of equipment testing, maintenance, training, and exercises. In preparation for a specific assurance visit, the SLD team and/or partner country participants will arrange for the availability of radiation sources based on their planned activities. For more guidance on assurance visits, please refer to the *Assurance Visit Policy Guidelines* and *Assurance Visit Practitioner Guidelines*.

Physical Description of Radiation Sources

As discussed earlier, one of the functions of the radiation sources is to provide specific, certified radiation type, energy, and activity levels that are used both for electronic RPM alignment and detector efficiency measurements, which form the technical basis for determining that the RPM meets the program MDQ performance requirement. Two gamma emitting isotopes, ^{57}Co and ^{137}Cs, and one neutron emitting isotope, ^{252}Cf, form the complete set of requisite radiation sources to fulfill these functions.

Isotopic Composition and Activity Level

The ^{57}Co and ^{252}Cf isotopes are deliberately selected because they exhibit radiation signatures at the RPM that mimic those of the threat (special nuclear materials ^{235}U and ^{239}Pu). The ^{137}Cs isotope is used for its distinct signature at higher gamma energies, important for proper RPM electronic alignment.

In addition to selecting these specific isotopes (for the type and energies of their radioactive emissions), specific ranges of radiation activity levels are prescribed. This is important for practical considerations associated with extrapolating RPM measurements to baseline performance standards. The ^{57}Co, ^{137}Cs, and ^{252}Cf radiation sources are procured from commercial vendors who provide the prescribed activity levels required by the program. Like all radioactive materials, activity levels of these radiation sources diminish over time. More clearly, the radiation sources exhibit a useful life (based on their rate of radioactive decay) that requires their periodic replacement during the operational lifespan of the radiation detection system. The technical details for these three sources, including emissions type, emissions energies, half-life, and recommended replacement period, are provided in Appendix A.

Physical Form of SLD-Deployed Radiation Sources

The sources procured and deployed by the SLD Program are fully encapsulated to safeguard that no loose or removable contamination can be released. This form factor is often referred to as radioactive sealed sources (RSS).

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[5] In some countries, local laws and regulations allow the use of commercial items containing naturally occurring radioactive materials (NORM) as gamma radiation sources for functional testing and operators training. Radium-painted gun sights, radium-painted instrument/watch dials/displays, thoriated welding rods, and lantern mantles are examples of such items.

Figure shows a typical RSS configuration. The two gamma sources, ^{57}Co and ^{137}Cs, are encased in plastic and manufactured by depositing the radioactive material in a plastic disc cavity that is sealed with epoxy and covered with an aluminum foil label. The labeling identifies the manufacturer, isotope composition, activity level, date of assay, serial number, and the text “RADIOACTIVE MATERIAL.” There are other RSS configurations but all are designed to contain the radioactive material during normal handling.

Figure 1. A Typical RSS Configuration

Radiation Health and Safety Considerations

The health effects due to exposure to ^{57}Co, ^{137}Cs, and ^{252}Cf radiation sources have been well studied, resulting in the establishment of internationally recognized exposure limits. These limits (expressed in terms of radiation dose) are used to safely control people working around and with radioactive materials at nuclear power plants and hospitals, for example. The installation, maintenance, and training activities and associated radiation sources discussed herein represent exceedingly small doses and accordingly are not formally considered as radiation work in most countries.

Radiation Dose Estimations and Comparisons

The radiation dose that an LMP or trainer would receive from the SLD-prescribed ^{57}Co, ^{137}Cs, and ^{252}Cf radiation sources for the full duration of their application (over years) present a very low health risk. This can be expressed in several ways:

- The International Atomic Energy Agency (IAEA) has addressed health risk posed by radiation sources by defining five categories[6]. Based on the emission energies and activity levels, the ^{137}Cs and ^{252}Cf sources used for operating and maintaining the radiation detection system are Category 5 sources (*Not Dangerous*; the lowest level). The risk posed by the ^{57}Co source is even lower; it is considered *Exempt* by the IAEA, essentially below the measurement scale.
- A calculation can be made to estimate the total radiation dose that an LMP will be exposed to as a result of performing the requisite tasks using the three radiation sources. The results suggest that the dose is a small fraction of the total dose due to naturally occurring radiation sources for the same person. A comparison can be provided for a range of activities.

Appendices B and C provide details of radiation doses due to working with the ^{57}Co, ^{137}Cs, and ^{252}Cf sources.

[6] *Categorization of Radioactive Sources,* IAEA TECDOC-1344

Best Practices for Radiation Source Handling

The final point concerning health and safety concerns associated with these specific radiation sources is a best practice of source handling called as low as reasonably achievable or ALARA. Regardless that these sources pose no measureable health risk, the LMP and trainer should handle them in a manner that minimizes the radiation exposure to themselves and others.

Administrative Considerations

Despite the innocuous health and safety concerns with the ^{57}Co, ^{137}Cs, and ^{252}Cf sources, there are strict administrative controls governing their procurement, transport, storage, and handling as with all radiation sources. These administrative controls are manifested in national and international regulations. It is paramount that SLD understand these regulations and processes and their impact on our collaborative work with partner countries. The program-specific details associated with licensing, procurement, shipment, storage, and disposal are addressed in the companion SLD document, *SLD Source Management Practitioner Guide*.

Radiation Source Licensing

The partner country end-user is responsible for obtaining the requisite licensing and ensuring that all national laws and regulations are satisfied. The process to acquire necessary permissions and licenses can be lengthy and should be initiated as soon as possible in the SLD implementation process. The SLD country manager and Sustainability lead should work closely with the partner country to facilitate the source licensing process.

Radiation Source Procurement

Typically, SLD arranges for procurement of the first set of radiation sources for the partner country. The partner country end-user (commercial or governmental) is responsible for the lawful receipt and use of the SLD-procured sources. An end-user statement must be signed and, in some cases, an import license obtained before the set of SLD-procured radiation sources can be exported from the commercial supplier. By signing the end-user statement, the consignee agrees to receive the radiation sources and accept all regulatory responsibilities associated with source ownership. As with licensing, the process leading to the receipt of sources in the partner country can take several months.

Source Shipping and Transport

Once the licensing and procurement processes are complete, the source shipping process can be initiated. The SLD project team and end-user (consignee) must make arrangements for the shipment to clear customs and complete the in-country shipment process to the designated storage facility.

Generally, the end-user will also be responsible for arrangements associated with the transport and shipping of the radiation sources within the partner country from the point of storage to the point of application, possibly at a port or site.

Secured Source Storage

As mentioned above, by signing the end-user statement, the partner country end-user must confirm that local regulatory requirements are met regarding control and management of radioactive materials, including secured storage. Typically, a simple two barrier solution meets most requirements; this can be simply a locked cabinet within a locked room or warehouse.

Inspections and Leak Checks

While local regulations can vary, international guidelines such as IAEA recommendations identify the ^{57}Co, ^{137}Cs, and ^{252}Cf sources as exempt from periodic leak testing. The SLD-procured radiation sources are leak tested prior to shipping from the supplier and documentation of the results is included with shipment paperwork. It is prudent that whenever the sources are removed for use, they should be visually inspected for damage, deformation, and/or physical degradation. A damaged source should be immediately removed from service and the supplier contacted for assistance.

Radiation Source Disposal

Finally, the partner country end-user is responsible for proper disposal of the radiation sources when they have exceeded their usable lives. In many cases, the radiation source supplier will take back the sources for a fee. Similar to procurement, there is a deliberate process for disposing of a radiation source that typically involves packaging and transport.

Roles and Responsibilities

The partner country source end-user and/or licensee are the principals assuming custodial responsibilities for the radiation sources. They handle, transport, and store the radiation sources in accordance with national regulations and laws. The partner country custodian may be a government agency or commercial entity. In many countries, the custodian is the partner country nuclear competency; in other countries, it is the partner country government agency providing maintenance for the radiation detection system.

When requested or as appropriate, the SLD Program will provide recommendations on appropriate source handling, storage, and accountability practices that could be adapted by the partner country custodian in accordance with relevant international and national regulations and requirements. In the end, the legal authorization and compliance obligations reside with the partner country custodian.

SLD Planning and Implementation Phase

The SLD country manager should conduct informed and timely discussions concerning procurement and receipt of the radiation sources. Typically, the partner country should be notified as early as practical, preferably during the SLD engagement process, of the need for radiation sources for installation and maintenance of the radiation detection system. The country manager will collaborate with the partner country to identify the appropriate organization responsible for obtaining proper licenses.

Based on partner country infrastructure, SLD should be prepared to offer training to authorized personnel for the storage, transport, and handling of radiation sources in support of the associated SLD-deployed systems and activities.

SLD Sustainability Transition Period

During the Sustainability transition period, SLD will continue to provide the appropriate level of assistance and guidance to the partner country in sustaining indigenous capabilities for the procurement, storage, transport, and handling of sources for the radiation detection system. Commercial suppliers and processes for radiation source disposal should be established. The partner country will be fully assuming these responsibilities along with the other requisite operational and maintenance activities.

Post-Transition Period

SLD headquarters will determine post-transition radiation source management and responsibility on a case-by-case basis. This will depend largely on the partner country infrastructure.

Table 1. Radioactive Source Management and Accountability Checklist and Timeline

Responsible Party	Roles
SLD Planning and Implementation Phase	
Partner Country/SLD Project Team	1. Determine regulatory and licensing requirements for source ownership 2. Determine timeline for source licensing, procurement, and shipping
Partner Country	1. Obtain necessary licenses (ownership, importation, shipping/ transportation, use) - Submit prescribed license application forms and documentation - Submit completed end-user statement to source vendor - Submit source storage plans and procedures if required 2. Arrange secure source storage location
SLD Project Team	1. Procure and ship initial radioactive check source inventory 2. Provide source-specific training to partner country and LMP
Partner Country	Receive sources and implement accountability measures
SLD Sustainability Transition Period	
SLD Project Team	1. Replace expired sources as required 2. Train partner country in source procurement and disposal procedures
Partner Country	Maintain source accountability and security
Post-Transition Period	
Partner Country	Responsible for all source-related activities
SLD Project Team	Assist partner country on source matters as required and agreed to

Conclusions

SLD installation, training, operations, and maintenance activities associated with the radiation detection system require the use of radiation sources of specific isotopes and activities. The storage, handling, transport, and disposal of such radiation sources are subject to national and international regulations. Technical information and program policy associated with these custodial responsibilities are provided in this document. A companion SLD document, *SLD Source Management Practitioner Guide*, addresses the practical aspects of a partner country's custodial responsibilities. Together, these two documents provide the requisite program guidance for licensing, procurement, storage, handling, transport, and disposal of the sources necessary to operate and maintain the radiation detection system.

Appendix A: Radiation Source Physical Characteristics

One of the functions of the radiation sources is to provide specific and certified radiation type, energy, and activity levels that are used both for electronic RPM alignment and detector efficiency measurements. These form the technical basis for determining that the RPM meets the program MDQ performance requirement. Two gamma emitting isotopes, ^{57}Co and ^{137}Cs, and one neutron emitting isotope, ^{252}Cf, form the complete set of requisite radiation sources to fulfill these functions. Some of the physical characteristics of these radiation sources are provided in Table A-1.

Table A-1. SLD Radioactive Source Requirements

Isotope	Initial Activity	Useful Activity Levels	Half Life (years)	Useful Life[7] (years)
^{57}Co	370kBq (10µCi)	370 – 37kBq (10 –1.0µCi)	0.75	2.47
^{137}Cs	370kBq (10µCi)	370 – 74kBq (10 –2.0µCi)	30.17	~30.
^{252}Cf	185kBq (5µCi)	185 – 59.2kBq (5 – 1.6µCi) ~ 20,000 – 6,500 N/sec	2.64	4.6

^{57}Co is used to measure the intrinsic efficiency of gamma detectors and electronics. It was chosen as a surrogate for ^{235}U due to its most prominent gamma energy emission at 122.06 keV, which is approximately equivalent to the attenuated, prominent energy peak of ^{235}U at 185.74 keV. ^{57}Co has a 272-day half-life and an SLD Program useful life of approximately 30 months, based on initial activity of 370 kBq (10 µCi)

^{137}Cs is used for gamma detector alignment and response testing, and is used to properly set and adjust the high-voltage and gain settings in the gamma detector electronics. It was chosen because it has a single, distinctive energy peak at 661 keV, the middle of the sensitivity range of the instrument. ^{137}Cs has a 30-year half-life and an SLD Program useful life of approximately 30 years, based on an initial activity of 370 kBq (10 µCi).

^{252}Cf is used to measure the intrinsic efficiency of the neutron detectors and electronics. It was chosen as a surrogate for ^{239}Pu due to the energy range of its neutron emissions. ^{252}Cf emits neutrons, has a 2.6-year half-life, and an SLD Program useful life of approximately 4.6 years, based on an initial activity of 185 kBq (5 µCi/)

Figure A-1. Typical gamma RSS

Figure A-2. Neutron RSS

[7] Source Useful Life is based on the assumption that the source is received having an initial activity as that listed above.

Appendix B: IAEA Categorization of SLD Radiological Sources

The risks posed by radioactive sources and material vary widely depending on such factors as the radionuclide, physical form, and activity. Recognizing the need for a graded approach to the regulatory control of radiation sources, IAEA's *Action Plan on the Safety of Radiation Sources and Security of Radioactive Material* called for development of categorization. As a result, the IAEA defined five categories, which are listed in TECDOC-1344. These categories, along with descriptions and activity ratios, are listed in Table B-1.

Table B-1. IAEA Description of Source Categories

Category	Description	Activity Ratio[8]
1	Personally Extremely Dangerous	A/D $\geq$ 1000
2	Personally Very Dangerous	1000 $\geq$ A/D $\geq$ 10
3	Personally Dangerous	10 $\geq$ A/D $\geq$ 1
4	Unlikely to be Dangerous	1 $\geq$ A/D $\geq$ 0.01
5	Not Dangerous	0.01 $\geq$ A/D $\geq$ Exempt/D

Table B-2 presents the results of calculations that indicate ^{57}Co is considered ***exempt*** by the IAEA and ^{137}Cs and ^{252}Cf are Category 5, which the IAEA considers ***not dangerous***.

Table B-2. SLD Source Categorization

Isotope[9]	Activity[9]	D-Value[10]	A/D Ratio	IAEA Exempt Quantity[11]	Exempt/D	IAEA Category 5 Criteria (A/D)[12]
Co-57	3.7E5 Bq[13]	7E11 Bq	5.3E-7	1E6 Bq	N/A – This source is Exempt	
Cs-137	3.7E5 Bq	1E11 Bq	3.7E-6	1E4 Bq	1E-7	1E-2 >A/D$\geq$Exempt/D
Cf-252	1.85E5 Bq	2E10 Bq	9.3E-6	1E4 Bq	5E-7	1E-2 >A/D$\geq$Exempt/D

The Isotope and Activity columns list the required isotopes and their activities. The D-value (danger value) is a number that the IAEA assigns to each isotope in a ranking of how dangerous a specific isotope is. The A/D Ratio, or activity divided by D-value, gives a specific indication of how dangerous the source is. The IAEA exempt quantity is the activity considered exempt from controls by the IAEA (our ^{57}Co source). The "Exempt/D" is a calculation to give a number for the next column, which lists the IAEA criteria for a source to fall into Category 5 (Not dangerous). Note that our A/D (activity-to-danger value ratio) puts both ^{252}Cf and ^{137}Cs into IAEA source Category 5 (***Not Dangerous)***.

[8] Unitless ratio used to determine the category of a source based on its activity and IAEA assigned 'D' (danger) value. From *Categorization of Radioactive Sources*, Table 1, Categorization Table, July 2003.
[9] Isotopes and activities required to perform alignment and testing of SLD RPMs.
[10] D-Value for selected isotopes from *Categorization of Radioactive Sources*.
[11] IAEA Exempt Quantities from IAEA Safety Series No. 115, *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources*, Schedule 1.
[12] From *Categorization of Radioactive Sources*, Table 1, Categorization table.
[13] 3.7E5 Bq = 3.7×10^5 Bq = 370 kBq

Appendix C: Anticipated Source Use and Dose Estimates

The expected total cumulative dose that may be received due to use of the specified radiation sources at most installations for the initial testing and first year of operation is less than 1 microSievert (μSv), which is insignificant compared to the IAEA allowable annual dose for radiation workers of 20,000 μSv/yr. In the following years, after initial installation and testing are complete, the expected total cumulative dose that might be received due to use of the check sources is less than 1.0 μSv per monitor. Again, this is an insignificant dose. Note that the expected cumulative dose by an employee at the average port from naturally occurring background radiation is approximately 1,000 μSv /yr based on IAEA information.

The following is an outline of the intended uses of these sources, projected frequency of their use, and estimated cumulative dose that could be received by a trained technician following industry standard as low as reasonably achievable and safe work practices.

Initial Alignment and Testing

The sources are used to setup and test the RPMs to establish optimal detection of target materials. Assumptions: holding all three sources for one hour, the ^{252}Cf source on a 24-inch handling device.

1hr/monitor x 1 monitor x 0.250 μSv/hr = 0.25 μSv total

Retesting After Repairs

If certain components are replaced during corrective maintenance, the sources must be used to retest the monitor's performance (performance checks after one failure and repair of each monitor in a year). Assumptions: Holding the ^{57}Co and ^{252}Cf for one hour, the ^{252}Cf source on a 24-inch handling device.

0.5hr/monitor x 1 monitor x 0.125 μSv/hr = 0.0625 μSv total

Periodic Performance Testing

The monitors must be tested annually to verify continued performance meets programmatic objectives. Assumptions: Holding the ^{57}Co and ^{252}Cf for one hour, the ^{252}Cf source on a 24-inch handling device

0.5hr/monitor x 1 monitors x 0.125 μSv/hr = 0.0625 μSv total

These projections are also based on the following assumptions:

1. All check sources are handled during the entire alignment and/or performance check procedure. In reality, source handling is limited to only one source at a time and only a few moments per procedure.
2. Each instrument will fail and require corrective maintenance, to include source use, once per year. In reality, on average the TSA RPM failure has historically occurred at a lesser frequency.
3. The sources should be handled using source handling devices, which minimize the handlers' exposure.
4. All source control and handling are performed by a single custodian designated by the source owner as outlined in the suggested Source Accountability and Control Procedure.

The cumulative dose from one year of source handling should be <4.0 μSv/yr per monitor. The accepted average annual worldwide dose is 2,888 μSv. Over 82% of this total is from natural sources, of which over half comes from natural radon decay products as shown in Figure C-1.

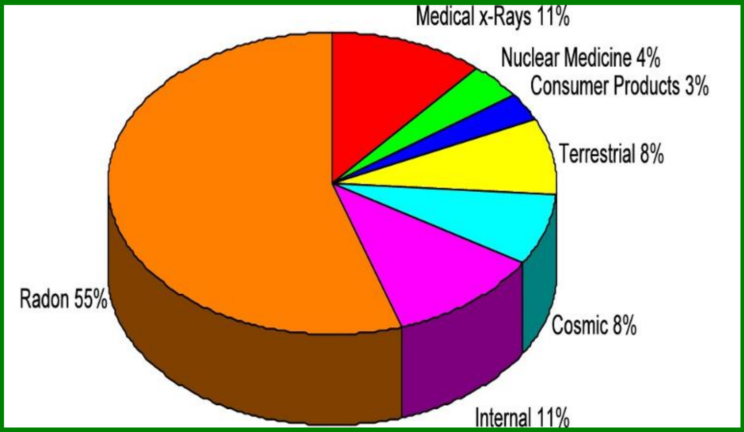

Figure C-1. Average Dose Amounts

Again, the total dose received from radiation source handling activities for a full year is much less than the expected radiation dose the average person receives annually from normal background radiation sources.